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(54) Method to detect manmade fibres and/or defective fibres and/or other foreign materials in the processing of silk waste, and relative apparatus.

(57) Method to detect manmade fibres, defective fibres and/or other foreign materials in the processing of silk waste and to classify and count the faults detected in the lap of silk fibres leaving a drawing frame for instance, the method arranging that a substantially defined zone of the lap of silk fibres (20) made substantially parallel is illuminated by transparency with white light (23) and is scanned by a telecamera (24) associated with a data processing system (27) and is also illuminated by transparency with polarized light (25) and is scanned at the same time by a telecamera (26), which too is associated with the data processing system (27), images (14-15) taken by the telecameras (24-26) being processed and compared to determine the quantity, position, type and length of the faults of manmade, foreign or defective fibres.

Apparatus to detect manmade fibres in the processing of silk waste in the form of fibres and to classify and count faults detected in a lap of silk fibres leaving a drawing frame, for instance, the apparatus comprising a transparent surface (36) on which is laid a lap of silk fibres (20) made substantially parallel, on which are present a first source of light and a second source of light, one of the sources being a source of white light (23) while the other source is a source of polarized light (25), the sources of light cooperating with at least one telecamera (24-26) positioned on the opposite side of the transparent surface (36) and associated with a data processing unit (27) and an identification unit (13).

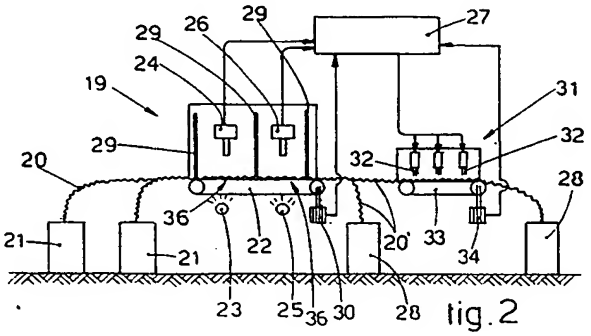

fig.2

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This invention concerns a method to detect manmade fibres and/or defective fibres and/or other foreign materials in the processing of silk waste, and the relative apparatus, as set forth in the respective main claims.

To be more exact, the invention concerns a method and the relative apparatus to identify manmade fibres, advantageously but not only polypropylene fibres, defective fibres and/or other foreign materials included in laps of silk fibres coming from the processing of silk waste.

Moreover, the method and the relative apparatus according to the invention enable the faults detected in the lap of silk fibres to be classified and counted and to be sorted by types.

This method and the relative apparatus are applied advantageously to the textile industry, for instance downstream of a drawing frame, and in particular to the quality control step, whether that step is performed by sampling or not.

This control of quality can be carried out either by a classification of the laps of silk fibres on the basis of the manmade fibres and/or the defective fibres and/or other foreign materials encountered or by combining the control with successive apparatuses so as to eliminate such faults and/or such manmade or defective fibres thus identified.

It is known that during recent years the old packages based on cellulose in which silk wastes were conveyed from their collection points to their recovery and re-use points have been replaced by packages containing manmade fibres, particularly polypropylene fibres.

The technology of the state of the art had already obtained a system to identify cellulose fibres in laps of silk fibres.

The technology of the state of the art has made possible the identification, on a lap of silk fibres leaving a drawing frame or like machine, of some types of faults by using the field of the data processing of images.

The present technique of the data processing of images is carried out substantially in three different successive steps, and in particular by the acquiring of the image, the data processing of the image and the actual identification of a determined type of foreign or defective fibres or materials.

According to the known methods the lap of silk fibres is fed forwards at a set speed and is scanned by a telecamera connected to a computer into which is loaded a programme that converts the visual image into data compatible for analysis.

Special algorithms make possible the identification of a series of faults present in the image taken by the telecamera, and the classification of the lap of silk fibres takes place on the basis of the faults detected.

But the technology of the state of the art is powerless in the case of manmade fibres and, in particular, polypropylene fibres. This situation therefore entails the shortcoming that these polypropylene fibres contaminate the silk fibres and impair the quality.

With the state of the art the various laps of silk fibres are classified automatically on the basis of the quantity and type of the faults.

This classification does not include the contamination by manmade fibres present in the lap of silk fibres since these manmade fibres are sometimes identified as being "not silk" but are not identified as being manmade fibres.

Such an improvement of the classification is still impossible as no method and therefore no apparatus exist for the identification of the manmade fibres present in laps of silk fibres.

At the present time the samples of laps of silk fibres are inspected visually by the appointed personnel, who try to detect any manmade fibres and, in particular, polypropylene fibres in the lap of silk fibres.

As this operation requires great care and concentration on the part of the machine operator, the present speed of inspection is about 0.4 to 0.5 metres of the lap of silk fibres per minute, and the outcome of this situation is that the classification of the laps of silk fibres is made on the basis of an inspection carried out on very small samples and that therefore the statistical results are sometimes not very reliable.

US-A-4,839,943 discloses a device to detect faults such as natural or manmade foreign fibres, knotted strings, bunches of synthetic materials, pieces of thread within or between tufts of particular loose textile fibres such as cotton, wool, etc.

The foreign fibres are detected on the basis of their various characteristics, such as configuration and/or colour and/or size and/or luminosity, but this method does not enable the faults to be detected by their type and limits itself only to the identification of everything which does not correspond to the fibre being processed at that time.

The device to detect faults comprises advantageously a means to transmit electromagnetic waves to a means which receives those waves, the two means being arranged opposite to each other on one side and the other side of the layer of fibres to be analysed.

The device to detect faults is of a camera or telecamera type and the images thus produced are stored and compared, by means of a suitable evaluation contrivance, with photographs stored in the device so as to identify as faults everything not consisting of the particular required fibre.

The detector device actuates a suitable removal means positioned downstream to remove the

faults previously identified.

Furthermore, this device cannot count nor classify the various faults as being what they are but makes a rough evaluation of the fibres and identifies everything which is considered as material foreign to the actual fibre being examined.

The device is applied, in fact, to fibres which are not scoured nor beaten but are merely opened and spread on a conveyor belt; the fibres contain great quantities of impurities such as seeds, vegetable fragments, dusts, etc., and these impurities are included even in quantities consisting of some percentage by weight of the mass being processed.

WO-91/11705 discloses a method to measure optically the characteristics of quality and quantity of textile fibres. The method enables, in particular, the length, fineness, degree of maturity and curliness of the fibres, whichever they are, to be established at the same time.

The method is applied to a single-layer sample of fibres consisting of a limited number of fibres made parallel and positioned between two glasses but cannot be applied to laps of continuous fibres for an in-line analysis and inspection process. Moreover, this method does not lead to identification of faults in the sample of fibres analysed and therefore does not enable the sample under examination to be classified on the basis of the type and number of faults identified.

So as to overcome the shortcomings of the state of the art and to achieve further advantages the present applicants have studied, tested and obtained this invention.

This invention is set forth and characterized in the respective main claims, while the dependent claims describe variants of the main idea of the solution.

The purpose of the invention is to identify automatically and reliably any manmade fibres and advantageously, but not only, polypropylene fibres and/or defective fibres and/or other foreign materials mixed with the discontinuous silk fibres in samples of laps of silk fibres coming from silk waste.

The method according to the invention makes possible also the detection of other types of faults such as hairs, knots, various contaminating fibres, defective fibres, etc., the classification of faults according to their type and the counting of faults by classes of types.

The method for detection of the manmade fibres according to the invention is based on the known method of data processing of images and is carried out in the three known different steps of acquiring the image, processing the image and actually identifying the faults.

This method is applied to the lap of silk fibres leaving a drawing frame or a machine or equipment suitable to make the fibres extremely parallel.

According to the invention two telecameras are employed at the same time in the image acquiring step and scan the lap of silk fibres having its fibres substantially parallel; the two telecameras are characterized in that one of them uses a source of white light, whereas the other uses a source of polarized light.

According to the invention the lap of silk fibres is illuminated by transparency by the two sources of light.

A great part of the faults in the lap of silk fibres is detected by the telecamera with the source of white light.

All the faults connected with the inclusion of polypropylene fibres are detected by the telecamera with the source of polarized light.

In fact, the fibres foreign to the silk and therefore also the manmade fibres, including polypropylene fibres, are generally more opaque and therefore, as we said above, are detected by the telecamera with the source of white light.

The telecamera with the source of white light enables the characteristics parameters of the contaminating fibres to be identified such as thickness, length, lack of continuity and opacity, which are used thereafter to identify the type of contaminating fibre detected.

But as the polypropylene fibres alone rotate the vector of polarization of the polarized light, the telecamera with the source of polarized light identifies only the polypropylene fibres.

Since the polypropylene fibres may have been "contaminated" by the treatment undergone by the silk or may be partly hidden by other fibres, the polarized light identifies the polypropylene fibres only partly but not their full extent.

According to a variant the source of white light is suitably filtered and/or coloured.

According to another variant there is only one telecamera, which carries out its scanning operations in succession by illuminating the zone to be observed now with white light and then with polarized light.

According to the above variant the step of acquiring the images is performed in a discontinuous manner and the lap of silk fibres is fed forwards step by step.

The data processing step consists generally of three procedures, namely an accentuation procedure, a procedure of conversion into binary signals and a compression procedure.

The procedures of conversion into binary signals and of compression are of a known type and may possibly be cancelled in the method according to the invention.

In the method according to the invention the accentuation procedure has been modified so as to

be able to accentuate the presence of contaminating fibres and of polypropylene fibres in particular.

During the step of accentuating the image scanned with white light all the fibres having a greater opacity are accentuated, thus identifying not only the slightly intertwined clusters of silk fibres but also all the contaminating fibres contained in the lap of silk fibres thus observed.

During the step of accentuating the image scanned with polarized light all the parts of the fibres are accentuated which rotate the plane of the polarized light, this being a typical feature of polypropylene fibres alone, as we said above.

In the third and last step of identification an analysis of the photograph taken by the telecamera with white light is carried out to identify the type of fault, while a combined analysis of the data obtained by data processing of the two separate images taken by the specific telecameras is carried out to identify the polypropylene fibres.

In fact, the analysis of the image taken with white light provides some characteristic parameters such as thickness, length, lack of continuity and opacity of the contaminating fibre.

For identification of the polypropylene fibres, instead, the image taken with the telecamera with polarized light provides the number and position of the polypropylene fibres, whereas the image taken with the telecamera with white light gives the extent of all the contaminating fibres.

By combining these data it is possible to obtain automatically the number of polypropylene fibres included and their respective lengths, thus providing information about the quality of the lap of silk fibres being examined.

In particular, the identification step includes substantially three successive steps, namely a first step to detect the characteristic parameters of the contaminating fibre, a second step to compare and catalogue the contaminating fibre and a third and last step to count the faults by types.

In particular, in the first step of detecting the characteristic parameters of the contaminating fibre the analysis of the image of the contaminating fibre taken with white light can provide parameters such as thickness, length, lack of continuity and opacity of the contaminating fibre.

In the second comparison and cataloguing step the above parameters are compared with an assembly of analogous values, each of which corresponds to a given class of faults, so as to catalogue the contaminating fibre in an exact class of faults.

The classes of faults are determined on the basis of fields of values of these characteristic parameters in such a way that the classes are separated and detached from each other, thus enabling the contaminating fibre to be apportioned to one single class.

Where the values of the characteristic parameters are such that the foreign fibre cannot be listed in any of the classes identified above, the foreign fibre is catalogued as an "unidentified fault" and is apportioned to the corresponding class.

Upon the apportioning of a contaminating fibre to a particular class of fault a counter relating to the identified class of fault is set to a higher value.

In the third step the detected faults separated by types of fault and indicated by the counters relating to the various classes are taken into account.

With the apparatus according to the invention it is possible to inspect laps of silk fibres running at a speed of 3 to 10 metres per minute, advantageously 4 to 6 metres per minute, thus enabling greater samplings to be carried out on the lap of silk fibres in question and therefore providing more reliable statistical results.

According to a variant a mapping step is included after the identification step and can be employed in a machine or equipment so as to eliminate, even selectively, faults or parts of the same.

The attached figures, which are given as a non-restrictive example, show a preferred solution of the invention as follows:-

Fig.1 shows a block diagram of the method according to the invention;

Fig.2 is a diagram of an apparatus according to the invention.

A method 10 to detect manmade fibres and/or defective fibres and/or other foreign materials in the processing of silk waste comprises substantially the following steps:

11 - acquiring the image of the lap of silk fibres to be checked;

12 - processing the images acquired in the previous acquiring step 11;

13 - identifying the faults, and in particular, the manmade fibres contained in the segment of the lap of silk fibres under examination.

According to the invention two images are obtained of the same zones of the lap of silk fibres during the acquiring step 11, in particular an image obtained with a source of white light 14 and an image obtained with a source of polarized light 15.

According to a variant the source of white light 14 is suitably filtered and/or coloured.

In this example the data processing step 12 consists, in a known manner, of three procedures, namely an accentuation procedure 16, a procedure of conversion into binary signals 17 and a compression procedure 18.

According to a variant the procedure of conversion into binary signals 17 and/or the compression

procedure 18 are eliminated.

In the method according to the invention the accentuation procedure 16 has been adapted to identify the faults in the lap of silk fibres and, in particular, to identify the contaminating manmade fibres.

In particular, the procedure 16 of accentuation of the image taken with white light 14 accentuates the fibres which are more opaque than the silk fibres; these more opaque fibres include the clusters of slightly intertwined silk fibres and the contaminating fibres.

The procedure 16 of accentuation of the image taken with polarized light 15 accentuates the fibres which cause rotation of the plane of polarization of the polarized light. This last step accentuates the polypropylene fibres comprised in the lap of silk fibres since the polypropylene fibres alone have the characteristic of rotating the plane of polarization of the polarized light.

The identification step 13 includes the combined analysis of data 14' and 15' obtained in the step 12 of processing the two images 14-15 obtained with the white light and polarized light respectively.

In the identification step 13 the contaminating fibres are classified which are detected by analysis of the data 14' obtained by analysis of the image taken with white light 14 on the basis of a plurality of classes, each of which defines an exact fault.

In particular, the identification step 13 includes a step of detection 37 of the characteristic parameters of the contaminating fibre identified.

In particular, values are obtained of some properties such as thickness, length, lack of continuity and opacity of the contaminating fibre.

Thereafter these characteristic parameters are compared 38 with analogous characteristic parameters determining an assembly of classes of faults so as to catalogue the contaminating fibre in a precise class of fault.

These classes of faults are characterized by well defined fields of the values of these characteristic parameters, so that the classes are separated and not superimposed; in this way the contaminating fibre can be listed in one single class of fault.

Where the properties of the contaminating fibre are not such as to enable the fault to be catalogued as belonging to one single class, then the contaminating fibre is listed in a special class called "unidentified fault".

Each class of fault is characterized by its own counter means, which is set to a higher value during the counting step 39 whenever a contaminating fibre is catalogued as forming part of that class of fault.

It is thus possible to know, in the case of each lap of silk fibres, the number of separate detected faults per type of fault and to catalogue the silk lap according to the number and type of faults encountered.

In particular, the combination of the data 14'-15' provides automatically, for instance, the value of the polypropylene fibres present within the lap of silk fibres being examined and thus enables the lap of silk fibres to be classified also according to the quantity of polypropylene fibres contained therein.

According to a variant a mapping step 35 is included after the identification step 13 and can be used in a machine or equipment to eliminate, even selectively, the faults or a part of the same.

Fig.2 is a diagram of an apparatus 19 to detect manmade fibres in a lap 20 of silk fibres. In this example the lap of silk fibres 20, which has its fibres made substantially parallel and emerges from cans 21, is fed along a conveyor belt 22 at a speed between 3 and 10 metres per minute, advantageously 4 to 6 metres per minute.

The conveyor belt 22 is driven by an appropriate motor 30 which is connected to a data processing unit 27.

The lap 20 of silk fibres, when it passes over an appropriate transparent surface 36, is illuminated by transparency by a first luminous source of white light 23 and is scanned by a first telecamera 24; it is then illuminated by a second luminous source of polarized light 25 and scanned by a second telecamera 26.

In the apparatus 19 according to the invention the luminous sources 23-25 and respective telecameras 24-26 are positioned respectively on the same axis as, and on opposite sides of, the lap 20 of silk fibres being examined, that is to say, the lap 20 of silk fibres runs between the respective luminous source 23-25 and relative telecamera 24-26.

In this example the luminous sources 23-25 are positioned below the lap 20 of silk fibres, whereas the telecameras 24-26 are positioned above the lap 20 in positions coordinated with the respective luminous sources 23-25.

In the apparatus 19 according to the invention the axes of the luminous sources 23-25 and telecameras 24-26 may be horizontal or vertical or be inclined as desired.

The scanning by the telecameras 24-26 is coordinated with the forward movement of the conveyor belt 22 and therefore with the feed of the lap 20 of silk fibres, so that the zones scanned by the first telecamera 24 always coincide with the zones scanned by the second telecamera 26.

In the method 10 according to the invention the order in which the scannings are performed is unimportant inasmuch as the results are the same

if the scanning with polarized light is carried out first and the scanning with white light is performed thereafter.

In fact, in the identification step 13 the data processing unit 27, receiving not only the images 14 and 15 but also the data of the speed of the conveyor belt 22, analyses at the same time the scannings of the same zone of the lap 20 of silk fibres.

The zones of illumination and scanning are screened by shields 29, which are advantageously black and non-reflecting, so as to avoid reflections or other difficulties.

The images 14-15 obtained by the first and second telecameras 24-26 respectively are transmitted to the data processing unit 27, in which they are processed so as to obtain as reliably as possible the identification of any manmade fibres and, in particular, any polypropylene fibres and/or defective fibres and/or other foreign substances in the lap 20 of silk fibres.

The data processing unit 27 can also list the detected contaminating fibres in an assembly of classes, each of which identifies a particular type of fault, by comparing the characteristic values of the contaminating fibre with the characteristic values defining those classes of faults.

The lap 20 of silk fibres, after this inspection, is collected in an appropriate can 28 or is passed beforehand through an assembly 31 which eliminates the faults and comprises operational means 32, which remove, even selectively, any faults encountered.

In this case the fault eliminating assembly 31 comprises a conveyor belt 33 driven by a motor 34 linked to the data processing unit 27 so as to ensure that the apparatus 19 detecting the faults is synchronized with the fault eliminating assembly 31 in order to remove such faults, even selectively.

Claims

1. Method to detect manmade fibres, defective fibres and/or other foreign materials in the processing of silk waste and to classify and count the faults detected in the lap of silk fibres leaving a drawing frame, for instance, the method arranging that a substantially defined zone of the lap of silk fibres (20) made substantially parallel is illuminated by transparency with white light (23) and is scanned by a telecamera (24) associated with a data processing system (27) and is also illuminated by transparency with polarized light (25) and is scanned at the same time by a telecamera (26), which too is associated with the data processing system (27), images (14-15) taken by the telecameras (24-26) being processed and compared to determine the quantity, position, type and length of the faults and of the manmade, foreign or defective fibres.

2. Method as in Claim 1, whereby the white light (23) and relative telecamera (24) are associated with a quality control system.

3. Method as in Claim 1, whereby the polarized light (25) and the relative telecamera (26) are associated with a quality control system.

4. Method as in any claim hereinbefore, whereby the lap (20) of silk fibres produced from silk waste is fed forwards substantially continuously, means being included to read the speed of feed of the lap of silk fibres (20) and being associated with a data processing system (27).

5. Method as in any claim hereinbefore, whereby the data processing system (27) is associated with an identification system (13).

6. Method as in any claim hereinbefore, whereby the identification system (13) includes the detection of parameters (37), their comparison and the cataloguing (38) and the counting (39) of faults.

7. Method as in any claim hereinbefore, whereby the counting (39) provides a counter means for each fault catalogued.

8. Method as in any claim hereinbefore, whereby the identification system (13) is associated with a mapping assembly (35).

9. Method as in Claim 8, whereby an assembly (31) to eliminate faults extends below the mapping assembly (35) and is located downstream of the fault detection area.

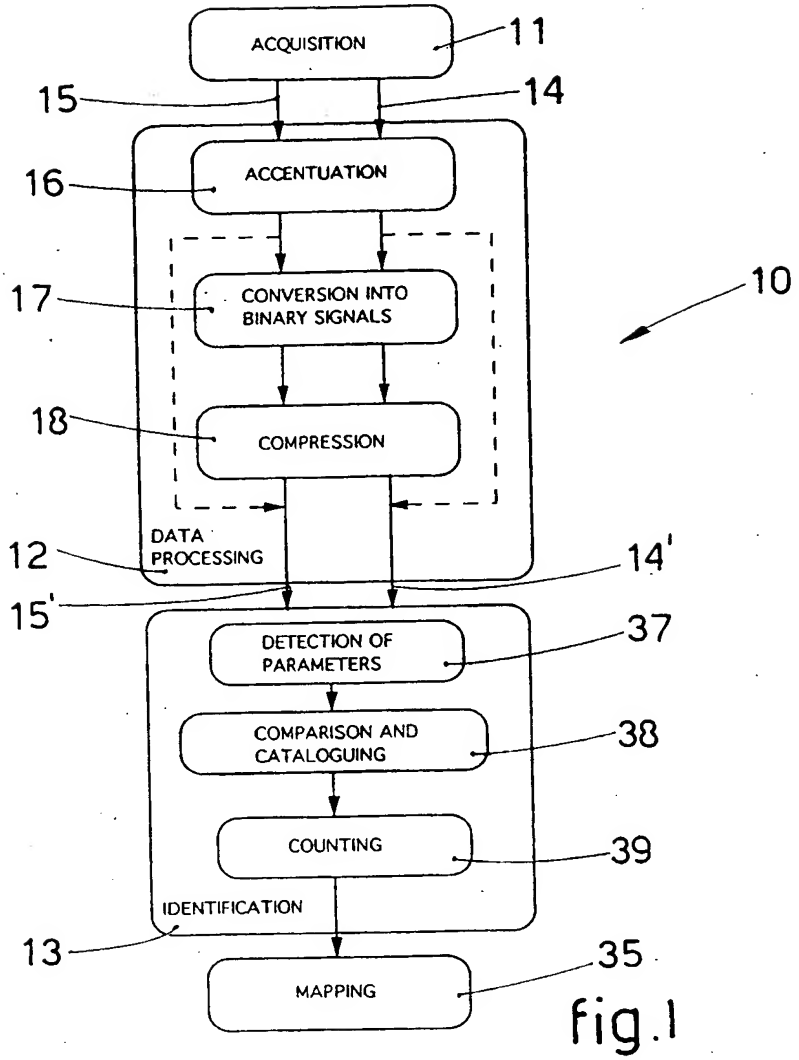
10. Apparatus to detect manmade fibres in the processing of silk waste in the form of fibres and to classify and count faults detected in a lap of silk fibres leaving a drawing frame for instance, the apparatus comprising a transparent surface (36) on which is laid a lap of silk fibres (20) made substantially parallel, on which are present a first source of light and a second source of light, one of the sources being a source of white light (23) while the other source is a source of polarized light (25), the sources of light cooperating with at least one telecamera (24-26) positioned on the opposite side of the transparent surface (36) and associated with a data processing unit (27) and an identification unit (13).

11. Apparatus as in Claim 10, in which one telecamera (24-26) is included for each source of light (23)-(25), shields (29) being also included to prevent disturbances.

12. Apparatus as in Claim 10 or 11, in which a conveyor belt (22) is included together with speed detection means associated with the data processing unit (27).

13. Apparatus as in any of Claims 10 to 12 inclusive, in which the data processing unit (27) is associated with an identification unit (13) and a mapping assembly (35).

14. Apparatus as in any of Claims 10 to 13 inclusive, in which an assembly (31) for at least partial removal of faults is included and is associated with the data processing unit (27).


ACQUISITION
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ACCENTUATION
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CONVERSION INTO BINARY SIGNALS
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COMPRESSION
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DATA PROCESSING
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DETECTION OF PARAMETERS
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COMPARISON AND CATALOGUING
38
COUNTING
39
IDENTIFICATION
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MAPPING
35

fig.1

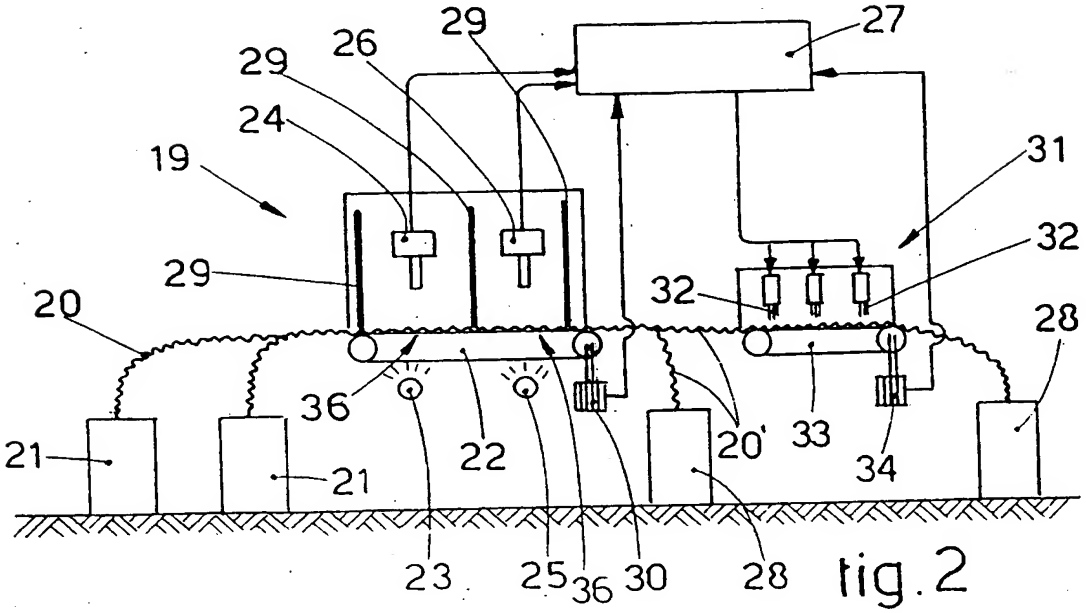
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fig.2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 92 11 9538

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A,D	WO-A-9 111 705 (SIEGFRIED PEYER AG) * page 7, line 17 - line 22; claims 1-13 *	1,10	G01N21/89 G01N33/36 G01N15/14
A,D	US-A-4 839 943 (F. LEIFELD) * claims 1-17 * * column 3, line 39 - line 54 *	1,10,12,14	
A	US-A-2 824 488 (W.BRIDGES ET AL.) * claims 1-3 *	10	
A	GB-A-808 505 (LICENCIA) * claims 1-9 *	1,10	
A	GB-A-2 242 266 (GEBRUDER LOPFE AG)		
A	EP-A-0 412 447 (MASCHINENFABRIK RIETER AG)		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

G01N
D06H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11 MARCH 1993	VAN DEN BULCKE E.J.

CATEGORY OF CITED DOCUMENTS

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